CHAPTER 4

METHODOLOGY

In this chapter, we will discuss the four important topics; the regression estimation method, hypothesis testing, CAI computation, and detail and source of data for computing the index.

4.1 The Estimation Method

To compute the CAI index, we need to use the econometric estimation of parameters for extracting the technology effect (or the Hicksian measure) and the endowment effect. In this study, the index is computed for 11 countries (including developed and developing countries) within ten selected industrial sectors[1]. Recalling equation (3.16), the estimation of industry-level production function is for each commodity sector i in country c as follows:

$$\ln\frac{X_{it}^c}{l_{it}^c} = \ln X_{0i} + \ln A_i^c + \lambda_i^c \cdot t + \alpha_{ki}\ln\frac{k_{it}^c}{l_{it}^c} + \alpha_{Ki}\ln K_{it} + \frac{\beta_{kki}}{2}(\ln\frac{k_{it}^c}{l_{it}^c})^2 + \frac{\beta_{KKi}}{2}(\ln K_{it})^2 + \beta_{kKi}(\ln\frac{k_{it}^c}{l_{it}^c})(\ln K_{it}) + u_{it}^c \qquad (4.1)$$

where $u_{it}^c = \rho_i^c u_{it-1}^c - v_{it}^c$ (unobservable productivity shocks). Besides the elasticity of output with respect to country specific capital is expressed as the following for all industry i and country c:

$$\frac{\partial \ln X_{it}^c}{\partial \ln k_{it}^c} = \alpha_{ki} + \beta_{kki}\ln\frac{k_{it}^c}{l_{it}^c} + \beta_{kKi}\ln K_{it} \qquad (4.2)$$

[1] See Table 1.A and Table 2.A in Appendix A.

The estimated simultaneous equation (4.1) and (4.2) allows us to obtain all parameters in the production function[2]. Since output data (X_{it}^{c}) also exhibits a unit root process, see Appendix E[3]. An existing of unit root process in output actually causes this regression estimation to not be reliable because the change in output is not independent with the time variable. Additionally, this estimation leads to a Durbin-Watson statistic that is close to unity for the labor cost share equation, indicating serious misspecification (Boskin and Lau, 1992). To resolve these problems, Boskin and Lau suggest that equation (4.1) must be transformed in terms of the first differencing in time as follows:

$$\Delta_t \ln\frac{X_{it}^{c}}{l_{it}^{c}} = \lambda_i + \alpha_{ki}\Delta_t \ln\frac{k_{it}^{c}}{l_{it}^{c}} + \alpha_{Ki}\Delta_t \ln K_{it} + \frac{\beta_{kki}}{2}\Delta_t(\ln\frac{k_{it}^{c}}{l_{it}^{c}})^2 + \frac{\beta_{KKi}}{2}\Delta_t(\ln K_{it})^2 + \beta_{kKi}\Delta_t(\ln\frac{k_{it}^{c}}{l_{it}^{c}})(\ln K_{it}) + v_{it}^{c} \quad (4.3)$$

where $\Delta_t \ln(X_{it}^{c}/l_{it}^{c}) = \ln(X_{it}^{c}/l_{it}^{c}) - \ln(X_{it-1}^{c}/l_{it-1}^{c})$

$\alpha_{ki}\Delta_t \ln(k_{it}^{c}/l_{it}^{c}) = \alpha_{ki}\left[\ln(k_{it}^{c}/l_{it}^{c}) - \ln(k_{it-1}^{c}/l_{it-1}^{c})\right]$

$\alpha_{Ki}\Delta_t \ln K_{it} = \alpha_{Ki}(\ln K_{it} - \ln K_{it-1})$

$(\beta_{kki}/2)\Delta_t \ln(k_{it}^{c}/l_{it}^{c})^2 = (\beta_{kki}/2)\left[\ln(k_{it}^{c}/l_{it}^{c})^2 - \ln(k_{it-1}^{c}/l_{it-1}^{c})^2\right]$

$(\beta_{KKi}/2)\Delta_t(\ln K_{it})^2 = (\beta_{KKi}/2)\left[(\ln K_{it})^2 - (\ln K_{it-1})^2\right]$

$\beta_{kKi}\Delta_t(\ln(k_{it}^{c}/l_{it}^{c}))(\ln K_{it}) = (\beta_{kKi})\left[(\ln(k_{it}^{c}/l_{it}^{c}))(\ln K_{it}) - (\ln(k_{it-1}^{c}/l_{it-1}^{c}))(\ln K_{it-1})\right]$.

Under profit maximization with competitive markets, the elasticity of output with respect to capital is equal to the share of capital cost (or 1 minus the share of labor cost). Therefore equation (4.2) can be rewritten as follows:

[2] Equation (4.2) needs to exist in the equation system for holding two assumptions: constant returns to scale and profit maximization (see Chapter 3).

[3] As the result of existing unit root process, $u_{it}^{c} = \rho_i^{c} u_{it-1}^{c} - v_{it}^{c}$, ρ_i^{c} is equal to one. Then the first difference in time of residual term will be v_{it}^{c}.

$$1-\frac{w_{it}^{c}l_{it}^{c}}{X_{it}^{c}}=\alpha_{ki}+\beta_{kki}\ln\frac{k_{it}^{c}}{l_{it}^{c}}+\beta_{kKi}\ln K_{it} \qquad (4.4)$$

According to the first assumption of production technology, it assumes that all countries are supposed to have access to the same production technology. In other words, it indicates that all similar countries are capable of having the same productivity and technology level (or the same common share parameters, see equation (4.3)[4]. Similar countries are possibly referred by the size of their economies. Therefore, in this study, 11 countries need to be separated into three country groups. The first group refers to Australia, Germany, the U.K., USA, and Japan. The second group represents NICs (New Industrial Countries): Korea and Singapore. The final group is the four developing countries in South East Asia: Malaysia, Indonesia, the Philippines, and Thailand.

To obtain common share parameters, we need to estimate a simultaneous equations system of (4.3) and (4.4) with the parameter restrictions between the two equations for each country group[5]. In other words, it is to say that the parameters for three groups are estimated separately by applying the 3SLS method. In addition, this estimation applies the panel data estimation by using a dummy variable as the fixed effect for technological rate parameters (λ_i^c) in each country. For example, in the first group, we need to put four dummy variables in equation (4.3) to represent the technological rate in four countries: Germany, U.K., USA, and Japan. To indicate the technological rate, λ_i^c represents directly the technological rate for Australia. In contrast, that of Germany is expressed as the sum of that of Australia and the dummy variable for Germany, see Appendix D.

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[4] The common share parameters in equation 4.3 are the same in all similar countries (or the same economy size), except two parameters; $\ln A_i^c$ and λ_i^c . In other words, two technological parameters in each country are different among all similar countries.

[5] Since this study needs to test the presence of externalities in production function, we must put three restriction conditions in the estimation of the simultaneous equation system. All details of these conditions are in Hypothesis Testing.

In fact, the differences in the initial efficiency level of inputs, $\ln A_i^c$, could not be estimated because of the first differencing. This constant term needs to be computed for each country and each industrial sector for 1970, 1980, and 1990 by using equation (4.5). In other word, it means that the residuals for these years are assumed to be zero[6].

$$\ln A_i^c = \ln \frac{X_{it}^c}{l_{it}^c} - \lambda_i^c \cdot t - \alpha_{ki} \ln \frac{k_{it}^c}{l_{it}^m} - \alpha_{Ki} \ln K_{it} - \frac{\beta_{kki}}{2} (\ln \frac{k_{it}^c}{l_{it}^m})^2 - \frac{\beta_{KKi}}{2} (\ln K_{it})^2 - \beta_{kKi} (\ln \frac{k_{it}^c}{l_{it}^m})(\ln K_{it}) \quad (4.5)$$

According to the regression estimation, regression parameters are divided into two groups: the technological parameters and the common share parameters. Each country has different technological parameters. On the other hand, the common share parameter is the same for all of countries which are in the same country group.

An instrumental variable (IV) estimator in this study is taken from Boskin and Lau (1992). These instrumental variables are as follows: relative price of cotton to wheat, relative price of oil to wheat, relative price of iron to wheat, world population, male population, female population, arable land, permanent crops, male life expectancy and female life expectancy.

Finally, the estimation of the industry level production function may cause the problem of the correlation between the regressor ($\ln(k_{it}^c / l_{it}^c)$) and the error term ($\ln u_{it}^c$) (Saito, 2004). This problem is possibly caused by measurement error, particularly in capital inputs.

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6 Notice that $\ln A_i^c$ is time-invariant term. It also represents the initial efficiency level of capital and labor input. On the other hand, λ_i^c is expected to capture all the changes in the quality of both factor inputs (Saito, 1999). However the technological progress level, λ_i^c , will not possibly capture all the changes so that the residuals (value of error term) by the end of the sample period tend to be large (Saito, 1999). Therefore $\ln A_i^c$ must be computed for these three years; 1970, 1980 and 1990.

4.2 Hypothesis Testing

According to the capital mobility across countries assumption, there will be probably the presence of externalities and returns from world aggregate capital. In fact, the presence of externalities could affect a change in productivity of each industry for all countries. A change in productivity also has impacts on a change in international comparative advantage. For that reason, this study needs to test the presence of externalities and the returns from world aggregate capital because this effect affects the value of the CAI index.

This test is actually similar to the test of whether the returns on world aggregate capital are the same as the returns on labor (Mika, 1999). With the production function specified in equation (3.16), the elasticity of output with respect to worldwide aggregate capital (K_{it}) is expressed as:

$$\frac{\partial \ln X_{it}^{c}}{\partial \ln K_{it}} = \alpha_{Ki} + \beta_{kKi} \ln \frac{k_{it}^{c}}{l_{it}^{c}} + \beta_{KKi} \ln K_{it} \qquad (4.6)$$

Assuming that the returns on aggregate capital and labor are the same, we obtain following condition:

$$\frac{\partial \ln X_{it}^{c}}{\partial \ln K_{it}} = \frac{K_{it}}{X_{it}^{c}} = \frac{w_{it}^{c} l_{it}^{c}}{X_{it}^{c}}$$

This assumption implies that equation (4.3) and (4.4) have the following parameter restrictions:

$$\alpha_{Ki} = 1 - \alpha_{ki} \qquad (4.7)$$

$$\beta_{kKi} = -\beta_{kki} \qquad (4.8)$$

$$\beta_{KKi} = -\beta_{kKi} \qquad (4.9)$$

Under this hypothesis testing, no externality (a constant returns to scale) will exist if the parameter restrictions (4.7) to (4.9) do not hold. In this case, the value of α_{Ki}, β_{kKi} and β_{KKi} are applied the following parameter restrictions:

$$\alpha_{Ki} = 0 \tag{4.10}$$

$$\beta_{kKi} = 0 \tag{4.11}$$

$$\beta_{KKi} = 0 \tag{4.12}$$

In fact, the parameter restrictions (4.7) to (4.9) need not to exist in the same time. For instance, the parameter restriction (4.7) is assumed to exist whereas other parameter restrictions do not hold. In this case, the parameter restriction (4.11) is applied (see Saito, 1999).

To see the result of the hypothesis testing, we examine the regression estimation result in each sector. If the estimation can hold all of the parameter restriction (4.7) to (4.9), then the externality and return from world aggregate capital will exist.

In this study, the regression estimation result shows that the parameter estimation, in all ten sectors, is followed as the hypothesis testing conditions (see Appendix D). As a result, it implies that the externality exists in all 10 industries of the three country groups.

4.3 The CAI Computation's Method

According to the previous chapter, equation (3.20) shows the way to compute the comparative advantage index (CAI) in the case of two similar countries (m and n countries). It implies that two dissimilar countries (different in the size of their economy size) cannot apply this computation method. Thus we need to adjust the CAI computation method for any two countries as follows (Saito, 1999):

$$\begin{aligned} CAI_{ijt}^{mn} &= PE_{ijt}^{nm} + WE_{ijt}^{mn} \\ &= TE_{ijt}^{mn} + EE_{ijt}^{mn} + WE_{ijt}^{mn} \end{aligned} \qquad (4.13)$$

where;

$$\begin{aligned} TE_{ijt}^{mn} &= TE_{jt}^{mn} - TE_{it}^{mn} \\ &= (\Delta \ln A_j - \Delta \ln A_i) + (\Delta\lambda_j - \Delta\lambda_i)\cdot t + \\ &\left[(\alpha_{kj}^m - \alpha_{kj}^n)\ln(k_{jt}^m / l_{jt}^m) - (\alpha_{ki}^m - \alpha_{ki}^n)\ln(k_{it}^m / l_{it}^m) \right] + \\ &\left[(\alpha_{Kj}^m - \alpha_{Kj}^n)\ln K_{jt}^m - (\alpha_{Ki}^m - \alpha_{Ki}^n)\ln K_{it}^m \right] + \\ &\left[(\frac{\beta_{kkj}^m - \beta_{kkj}^n}{2})(\ln \frac{k_{jt}^m}{l_{jt}^m})^2 - (\frac{\beta_{kki}^m - \beta_{kki}^n}{2})(\ln \frac{k_{it}^m}{l_{it}^m})^2 \right] + \\ &\left[(\frac{\beta_{KKj}^m - \beta_{KKj}^n}{2})(\ln K_{jt}^m)^2 - (\frac{\beta_{KKi}^m - \beta_{KKi}^n}{2})(\ln K_{jt}^m)^2 \right] + \\ &\left[(\beta_{kKj}^m - \beta_{kKj}^n)\ln(k_{jt}/l_{jt})\ln K_{jt} - (\beta_{kKi}^m - \beta_{kKi}^n)\ln(k_{it}/l_{it})\ln K_{it} \right] \end{aligned}$$

$$\begin{aligned} EE_{ijt}^{mn} &= EE_{jt}^{mn} - EE_{it}^{mn} \\ &= \left[\alpha_{kj}^n \Delta\ln(k_{jt}/l_{jt}) - \alpha_{kj}^n \Delta\ln(k_{it}/l_{it}) \right] + \\ &\left[(\beta_{kkj}^n/2)\Delta(\ln k_{jt}/l_{jt})^2 - (\beta_{kki}^n/2)\Delta(\ln k_{it}/l_{it})^2 \right] + \\ &\left[(\beta_{kKj}^n)\Delta\ln(k_{jt}/l_{jt})\ln K_{jt} - (\beta_{kKi}^n)\Delta\ln(k_{it}/l_{it})\ln K_{it} \right] \end{aligned}$$

$$WE_{ijt}^{mn} = \Delta \ln w_{it} - \Delta \ln w_{jt}.$$

Notice that the wage effect and the productivity effect formula is not changed. On the other hand, the method of computing the technology effect (TE) and the endowment effect (EE) is not the same as equation (3.20). In the theoretical framework, the sum of TE and EE is equal to the productivity effect (PE) (see equation 4.13). However, it needs not to exist all the time because the regression estimation may not capture accurately the technology effect and endowment effect[7]. It is to say that the identity of equation (4.13) will exist if a residual term (the difference between the productivity effect and the sum of TE and EE) is always zero. In terms of the productivity effect, it is directly computed by using the cross-country difference in labor productivity in two sectors (i and j) between two countries (m and n) (see equation 3.14). To compute the comparative advantage index (CAI) easily, this study assumed that there is not any residual term in the period of 1970-2000. Additionally, the technology effect (TE) is computed by following equation (4.13). On the other hand, the way to compute the endowment effect (EE) is adjusted by using the identity of equation (4.13). In other words, the endowment effect is equal to the difference between the productivity effect and the technology effect (or EE = PE - TE).

Finally, in this study, the comparative advantage index (CAI) is computed for 11 countries in three periods: 1974, 1994, and 2000. Since presenting the entire CAI result would be very large, we cannot show the entire comparative advantage index table between any pair of two countries.[8] Therefore, this study presents only the CAI between Thailand and other countries because this study aims to investigate the change in Thailand's comparative advantage in its industrial sector (compared to other countries).

[7] The data collection potentially faces a problem of measurement error. Thus it leads to an error in regression estimation.

[8] In the case of computing the CAI between any pair of two countries in 11 countries, there are 55 country combinations in each sector (see Appendix C). If we present the entire CAI result, then there is a large number of CAI tables in this study.

4.4 Data Description

To compute the CAI index, there are five industry-level data set for each industry i in country c at time t: output (X_{it}^{c}), capital input (k_{it}^{c}), labor input (l_{it}^{c}), labor wage (w_{it}^{c}), the labor cost share ($(w_{it}^{c}l_{it}^{c})/X_{it}^{c}$), and industry aggregate capital stock (K_{it}). These industry-level data are directly taken from the International Sectoral Database. In this study, the source of data is based on the United Nations Industrial Development Organization (UNIDO). Additionally, the industry data of non-OECD countries were collected by UNIDO while that of OECD countries were collected by OECD as provided to UNIDO. These industry-level variables are as follow:

GDP_{it}^{c} : Value added of output at market price, US dollar currency

KTV_{it}^{c} : Gross fixed capital information at market price, US dollar currency

EE_{it}^{c} : Number of employees during the reference year

W_{it}^{c} : Wage and salaries at market price, US dollar currency

In this study, the variables, X_{it}^{c}; k_{it}^{c}; l_{it}^{c} and w_{it}^{c}, correspond to GDP_{it}^{c}, KTV_{it}^{c}, EE_{it}^{c} and W_{it}^{c}. The labor cost share ($(w_{it}^{c}l_{it}^{c})/X_{it}^{c}$) and aggregate industrial capital stock (K_{it}) are respectively computed as follows:

$$\frac{W_{it}^{c}}{GDP_{it}^{c}} \quad \text{and} \quad K_{it} = \sum_{c=1}^{11} KTV_{it}^{c} \,.$$

However the industry-level data for developing countries—Thailand, Malaysia, Indonesia, and the Philippines— have limitations of data collection. In particularly, gross fixed capital formation is lacking for many years during the 1970 - 2000 period. Thus this study must estimate some industry-level data for these countries in order to use them in computing the CAI index. The estimation of these data is based on the available data of UNIDO and industry-level data of each country.

Finally, an instrumental variable is taken from the World Bank and FAO (Food and Agriculture Organization) database.